PLANT BREEDING

Traditional farming can only yield → limited biomass as food for → Humans, Animals

- Better management practises
- Increase in acreage

→ can increase → Yield to → limited extent

Plant breeding as technique → has helped increasing → Yield

GREEN REVOLUTION → has helped → meeting national requirement in food production, Export

depends to large extent on

PLANT BREEDING TECHNIQUE → for → development of high yielding varities, Disease resistant varities → of → Wheat, Rice, Maize

What is Plant Breeding?

is → purposeful manipulation of plant species → in order to → Create desired plant types → better suited for cultivation → give → Better yields, disease resistant.

CONVENTIONAL PLANT BREEDING → has been practised for → thousands of years → since the beginning of human civilisation

Recorded evidence of plant breeding → dates back to → 9000 - 11,000 years ago

- Many present day crops → are the result of → domestication in ancient times
- Today all major food crops → are derived from → domesticated varities

CLASSICAL PLANT BREEDING → involves → crossing OR hybridisation → of pure lines → followed by → artificial selection → to produce plants with desirable traits of → higher yield, nutrition, Resistance to disease

With advancement in → genetics
→ Molecular biology
→ Tissue culture

→ Plant breeding is now increasingly being carried out by using molecular genetic tools

★ Traits breeders have tried to incorporate into crop plants

- ↑ crop yield
- ↑ quality
- ↑ tolerance to Environmental stress
  - drought
  - extreme temp
  - salinity
- resistance to pathogens → virus, bacteria, fungi
- ↑ tolerance to insect pesticide.

★ Plant Breeding carried out in a systemic way world wide in → Govt. institution, → commercial companies

★ The main steps in breeding a new genetic variety of a crop —

(i) COLLECTION OF VARIABILITY:

★ Genetic variability root of any breeding programme ★

In many crops → pre-existing genetic variability is available from → Wild relative of the crop

Collection Preservation of all different Wild → Varities, species, Relatives } of → cultivated species followed by evaluation for their characteristics

pre-requisite for → effective exploitation of natural genes

Germplasm Collection → Entire collection of → plants, seeds } having all alleles for all genes diverse available in populations

Given crop in a

(ii) EVALUATION & SELECTION OF PARENTS:

Germplasm → evaluated → so as to identify plants with desirable combination of characters.

selected plants are multiplied → Used in process of hybridisation

★ Purelines are created whenever → desirable, → possible

(ii) CROSS HYBRIDISATION AMONG THE SELECTED PARENTS :

Desired characters —have→ very often to be combined from 2 different plants (parents)

Eg → High protein quality of one parent × (crossed) Disease resistant from another plant

posible by

Cross hybridising 2 parents to produce → hybride that

Genetically combined the desirable characters in one plant

This part → very time consuming / tedious process since → pollen grains (from ♂) have to be collected

pollen grains collected on stigma of selected plated plants.

also

Its not necessary that hybrids do combine the desirable characters

Usually 1/100 or 1000 crosses give desirable combination

(iii) SELECTION & TESTING OF SUPERIOR RECOMBINANTS:

This step consists → selecting among progeny of hybrids

Those plants have desired character combination.

Selection process crucial to the success of breeding objective

and required → careful scientific evaluation of progeny.

- This step yields → plants that are superior to both of parents (plants).

very often → more than one superior progeny plant may become available.

These are self pollinated → for several generation till they → a state of uniformity (HOMOZYGOSITY) so that the characters will not segregate in the progeny.

(V) TESTING, RELEASE AND COMMERCIALISATION OF NEW CULTIVARS:

- Newly selected lines are evaluated for their Yield & other agronomic traits of quality, disease resistance
- Evaluation is done by → Growing these in the research fields (1) & recording their performance (2)
- under.
  - ideal fertilizer application
  - Irrigation
  - Crop management practices.

Evaluation in research fields is followed by testing the material in farmer's field for atleast 3 growing seasons at several locations in country representing all the agro-climatic zones where Crops are usually grown

★ Material is evaluated → in comparison to → best available local crop cultivar known as Check / Reference cultivar

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INDIA is → Agricultural country

Agriculture accounts for → 33% of India's GDP

employs ≈ 62% of population

After India's Independence one of main challenges prod. enough food for ↑ population

As only limited land fit for cultivation

INDIA has to strive ↑ yields/area (from existing farm land)

GREEN REVOLUTION → Development of several high yielding varieties of wheat & rice in mid 1960s as a result of various plant breeding technique led to → Dramatic ↑ in food production in country.

Wheat

During 1960 – 2000 → Wheat production increases → 11 – 75 million tonnes → due to development of dwarf varieties

In 1963 → Sonalika + Kalyan sona → high yielding + disease resistant → introduced all over the wheat growing belt of India

Nobel Laureate → Norman E. Borlaug → developed Mexico semi dwarf wheat → at International Centre for Wheat Maize Improvement

Rice

During 1960 – 2000 → Rice production increases → 35 – 89.5 million tonnes → due to development of dwarf varieties

Semi dwarf Rice varities derived from

- IR-8 → developed at IRRI Philippines (International Rice research Institute)
- Taichung Native 1 → from Taiwan

→ introduced in 1966

Later introduced → Jaya, Ratna → developed in India

Sugar Cane → Saccharum Barberi

Was originally grown in North India but had poor yeild, poor sugar content.

Tropical canes grown in South India (Saccharum Officinarium) did not grow well in North India. had thick stems, higher sugar content.

* These 2 species → successfully → Crossed → to get → Sugar Cane varities combining desirable quality of:
- High yeild
- High Sugar
- Ability to grow in North India
- Thick stems

MILLETS → Hybrid maize, Jowar, Bajra → have been → Successfully developed in India

Hybrid Breeding → have led to → development of several high yielding varieties → resistant to → Water stress

Plant Breeding For Disease Resistance

- Wide range of → fungal pathogen, viral, Bacterial → affect the yeild of crop/cultivated crop species → especially in Tropical climates
- Crop losses can be signif upto 20-30% / sometimes total
  - resistant to disease ← Cultivars ← breeding / Develpm-ent ← In this situation
  - enhances food production
  - this also helps → Reduce the dependance on use of fungicides, Bactericides

Resistance of host plant is the ability to prevent the pathogen from causing disease
- determined by → Genetic constitution of host plant

Before breeding is undertaken we should know → Causative organism, Mode of transmission

Disease caused by
- Fungus
  - Brown rust of wheat
  - Red rot of Sugarcane
  - Late blight of potato
- Bacteria
  - Black Rot of Crucifers
- Virus
  - Tobacco mosaic
  - Turnip mosaic

Methods of Breeding for Disease Resistance:

Breeding is carried by either for

Conventional Breeding Technique

This method is of
- Hybridisation
- Selection

Its steps are essentially identical to those for Breeding for any other agronomic characters such as High yield.

Mutation Breeding

Mutation a process by which Genetic variations are created through changes in Base sequence within genes resulting in
- Creation of a new character
- Trait not found in the parental type.

...ious Sequencial steps

1) screening germplasm → for → Resistance sources

2) Hybridisation of selected parents

3) Selection / Evaluation → of → hybrids

4) Testing / Release → of → new varities

★ By this method → resistances developed

space for table

Conventional Breeding is often constrained by

"availability of limited no. of disease resistance genes"

that are present & identified in

Various crop varities | Wild relatives

⊙ Is possible → to → induce mutations artificially

Page:

through use of

chemicals | Radiations like γ-radiations

OR

⊙ By selecting & using the plants

having desirable characters.

as a source in breeding

this process is → MUTATION BREEDING

★ Eg. MUNG BEAN → resistance to → Yellow mosaic virus | Powdery mildew

mutation introduced by

⊙ Several wild relatives of → different cultivated species of plants

have been shown to have certain resistance characters but have ↓↓ yield.

Hence → there is need to introduce resistant genes into High yielding cultivated varities

Eg → ABELMOSCHUS ESCULENTUS (bhindi) → resistance to → Yellow mosaic virus

PARBHANI KRANTI ← resulted in new variety

All above examples me involve

Source of Resistance genes that are in

Same crop species → which has to be bred | Related wild species

Inducing mutations → in → plants → through → diverse means → then → screening the plant material → for → Resistance

sometimes lead to → desirable genes being identified

Plants having → desirable characters

can be either/or

- multiplied directly
- Used in breeding

- Other breeding methods used are → Selection among Somaclonal variants
- Genetic engineering

for disease resistance

★ Transfer of genes is achieved by

Sexual hybridisation

- target
- source plant

followed by Selection

Plant Breeding For Developing Resistance to Insect Pests

due to insect & pest infestation → major cause for large scale destruction of

- Crop plant
- Crop produce

⊙ Insect Resistance in Host crop plants may be due to:
- Morphological charact.
- biochemical charact.
- ~~physiological charact.~~

⊙ Hairy leaves in several plants → associated with → Resistance to insect pests.

eg.

Cotton = Resistance to → Jassids

Wheat = Resistance to → Cereal leaf beetle

- In wheat → Solid stems → lead to → non-preference by the Stem sawfly.
- In cotton → smooth leaved / Nectariless cotton → do not attract → Bollworms

maize → High apparic acid, Low nitrogen, Sugar content → leads to resistance to Stem borers.

★ Breeding methods for insect pest resistance → involves → Same steps as those of any other agronomic trait such as Yield, Quality

★ Source of Resistance genes → Cultivated varities, Germplasm collections, Wild relative

Plant Breeding for Improved Food Quality

◉ More than 840 million people in world → do not have adequate food to meet → daily food, Nutritional requirements.

◉ > 3 billion suffer from → Micronutrient, Protein, Vitamin, OR Hidden hunger → deficiencies → bcz they cannot afford to buy it

◉ Diets lacking → Essential micronutrients → Fruits, Vegetable, legumes, fish, meat

particularly → Fe, Vit-A, Iodine, Zn

→ Risk for disease
→ Reduce lifespan
→ Reduce mental abilities

Biofortification → Breeding crops with → With higher level of → vitamins, minerals, protein, healthier fats

most practical way to improve public health

Breeding for → Improved nutritional Quality is undertaken with objective of

- Protein → content, Quality
- Oil → content, Quality
- Vitamin Content
- Micronutrient & mineral content

In 2000 → Maize hybrids had → 2X amt of amino acids → Lysine, Tryptophan as compared to existing maize hybrids

⊙ Wheat variety → Atlas 66 have ↑ protein content → been used as a donor for improving wheat.

⊙ It is possible to develop → Rice Variety iron fortified → having 5X amt of Fe

IARI, New Delhi has released → Several vegetable crops that are rich in → vitamin, minerals

Vitamin A enriched	Vitamin C enriched	Fe & Calcium Enriched	Protein enriched
• carrots • spinach • Pumpkin	• bitter gourd • bathua • mustard • Tomato ~~• Beans~~	• spinach • bathua	Beans → Broad bablab, French beans, Garden beans

SINGLE CELL PROTEIN

Conventional Agricultural Production of → cereals, pulses, vegetables, fruits →

• may not be able to meet demand of food at the rate at which
- is increasing ← Human
- Animal population

★ The shift from grain to meat diets → also creates → more demand for cereals
- animal farming ← by ← 1 kg of meat ← to produce ← 3-10 kg of grain ← as it takes

★ >25% of human population is suffering from:
- hunger
- malnutrition

★ One of alternate sources of proteins for:
- animal
- human nutrition

(SCP) Single Cell proteins

★ Microbes are being grown on an industrial scale as a source of Good protein

BGA like → Spirulina → can be grown easily on materials like
- Waste water from Potato processing plants (containing starch)
- Molasses
- Animal manure
- Sewage

to produce → Large quantities & can serve as food rich in
- protein
- minerals
- fats
- carbohydrates

* Incidentally such utilisation reduces environmental pollution

★ Certain bacterial species like Methylophilus, Methylotrophus → produce 25 tonnes of protein
- bcz of its high rate of
  - Biomass prod.
  - Growth.

★ The fact that → Edible mushrooms are eaten by many people
- Large scale mushroom culture is a growing industry
- makes us believe
- Microscopic fungi too would become acceptable as food.

TISSUE CULTURE

As traditional breeding technique failed to meet demand & provide sufficiently fast & efficient system for crop movement.

than this got developed

It was by scientists during 1950's → whole plant from any → EXPLANT

any part of plant taken out & grown in test tube ← definition

under Sterile conditions in → Special nutrient media → TOTIPOTENCY → Capacity to generate a whole plant from any → cell/ Explant

* Nutrient Media must provide → Carbon source (Sucrose), Inorganic salts, Vitamins, AA, Growth regulators like cytokinins, auxins

By application of → these methods → its possible to achieve propagation

large no. of plants → in → very short duration

This method producing thousands of plants in very short time through tissue culture is called MICRO-PROPAGATION

Each of these plants will be → Genetically identical to original plant i.e they are SOMACLONES

plants generated commercially by this → tomato, banana, Apple.

* Another imp. application → Recovery of healthy plants from diseased one.

Even if plant is infected with a virus

One can remove meristem hence → and grow them in vitro to obtain → Virus free plants

Meristem: apical, axillary is free of virus

Scientists have succeeded in culturing meristems of → banana, Sugarcane, potato.

Scientists have isolated → single cells

born 2 inspire

Date ___/___/___

from plants after digesting their cell walls

have been able to isolate naked protoplasts from 2 different varieties of plants

each having a desirable character

can be fused to get → Hybrid protoplasts

can be further grown into new plant

These hybrids are called → Somatic hybrids

Process is called Somatic hybridisation

Protoplast of Tomato + Protoplast of Potato → grown to form → New plants (hybrids)

combining Tomato & Potato characteristics

This has been achieved

resulting in form of POMATO

unfortunately

Plant didn't have all desirable combination for commercial utilisation

born 2 inspire

Date ___/___/___

Q. Various components of medium used for propagation of an explant in vitro?

- Carbon source - sucrose
- Vitamins
- Minerals
- Water
- Agar Agar
- Auxin
- Gibberellin
- AA.

1. Tissue culture
2. Somatic hybridisation

→ Offers vast potential for manipulation of plants IN VITRO to prod. new varieties